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Contaminated land and wetland remediation in Nigeria: Opportunities for sustainable livelihood creation

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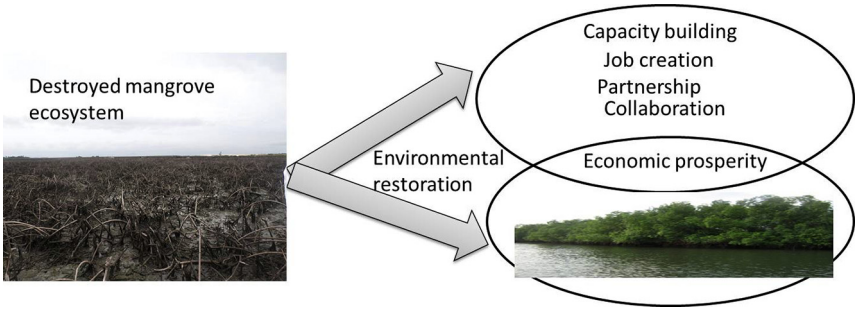
HIGHLIGHTS

- The Niger Delta region has experienced extensive soil, surface and ground water contaminations resulting from crude oil spills
- Economic livelihood structures has been destroyed and local economy dislocated
- Bioremediation is likely the appropriate approach given its effectiveness in remediating crude oil, and limited environmental footprint and contribution to climate change.
- The remediation exercise presents opportunities for sustainable job creation and economic development that could be applied in other regions globally.
- For sustainability and avoidance of conflict, government should institutionalise the process and make the regulatory authority financially independent.

GRAPHICAL ABSTRACT



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ABSTRACT

The Niger Delta region of Nigeria is one of the most crude oil impacted deltas globally. The region has experienced over five decades of oil related contamination of the total environment (air, soil, water and biota). In 2011, UNEP released a seminal report on oil impact on Ogoniland environments, which up scaled demands for urgent clean up and restoration of degraded bio-resource rich environments of the Niger Delta, starting from Ogoniland. The Nigerian Government demonstrated renewed political will to remediate contaminated sites in Ogoniland with a launch of the clean-up exercise in June 2016. Stakeholders' expectations from the clean-up include not only environmental remediation but also restoration and creation of sustainable livelihood opportunities to reduce poverty in the region. Most studies have focused on the environmental restoration aspect and identified bioremediation as the likely appropriate remediation approach for Ogoniland, given its low environmental footprints, and low-cost burden on the weak and overstretched economy of Nigeria. This study mapped opportunities for sustainable livelihood creation during the Ogoniland remediation and restoration exercise. Given the value chain of bioremediation and its ancillary activities, the study analysed opportunities and mechanisms for skilled and unskilled job creation and prospects for sustainable livelihoods and knock-on effects. It is anticipated that the clean-up process would lead to economic prosperity and mitigate resource-driven conflicts in the Niger

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Delta. The study provides an exemplar for waste-to-wealth transformation in regions where natural resource mining has impacted communities, and has dislocated local economies and age-old livelihood structures.
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1. Introduction

Crude oil exploration and exploitation has been the mainstay of the Nigerian economy for over five decades. The region that produces the oil, the Niger Delta, holds considerable oil reserves (37.4 billion barrels) (OPEC, 2017a) and natural gas (192 trillion standard cubic feet), in addition to hosting one of the most bio-diverse ecosystems globally (NDDC, 2014). The Niger Delta covers an area of 112,000 km^2 (Fig. 1) and comprises a number of ecologically sensitive regions (e.g. coastal barrier islands, mangrove and freshwater swamps) (NDDC, 2014). The region is densely populated, comprises of nine states, with approximately 31 million people whose primary livelihoods include food production and fisheries (Pegg and Zabbey, 2013; Sam et al., 2017a; UNEP, 2011).

Reports estimate the average export value of oil from the region to be $89 bn per annum, or in excess of $600 bn since 1960 (Akpabio and Akpan, 2010; OPEC, 2017b; Sam et al., 2017b). Thus, the oil sector is vital to the Nigerian economy contributing up to 11% of Nigeria's gross domestic product (GDP), and over 90% of its foreign exchange wealth (National Bureau of Statistics, 2016; OPEC, 2017a).

Since the inception of the Nigerian oil sector, 13 m tonnes of hydrocarbons have reportedly been spilled into the Niger Delta environment (Ite et al., 2013; Linden and Palsson, 2013) causing considerable contamination of the region's land and coastal environments (Ajayi and Ikporukpo, 2005; Sam et al., 2017a; UNEP, 2011). Despite this relatively lengthy history of oil development and ancillary environmental impact (e.g. oil spill), successive Nigerian governments have been ineffective and unhurried in developing governance structures and strategies to prevent and clean-up contaminated land (Ajayi and Ikporukpo, 2005; UNEP, 2011). Consequently, the Niger Delta has been and continues to be the hub of oil related contamination in Nigeria (Zabbey and Olsson, 2017), with an estimated over 2000 land-based sites that are contaminated with oil (Ite et al., 2013; Sam et al., 2017b).

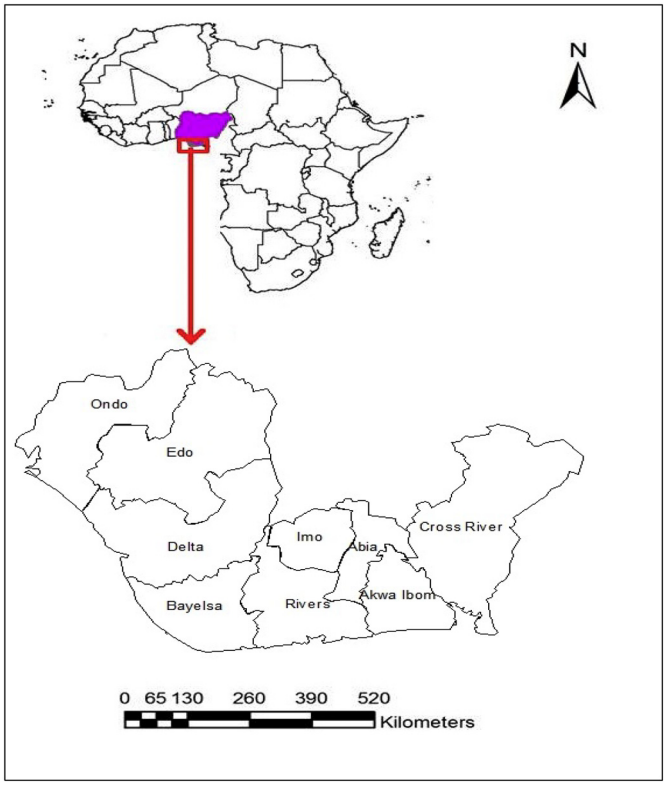

Fig. 1. The Niger Delta region of Nigeria comprises of nine States.

Consequently, the Niger Delta has been described as one of the most heavily oil-impacted regions in the world, with over five decades of oil exploitation activities, bunkering and oil theft, illegal (artisanal) refining practices, sabotage activity (e.g. Niger Delta Avengers), and historic war damage (e.g. Ejama) (Zabbey and Uyi, 2014). Oil contamination in the region has a demonstrable impact on the exposed human populations and the environment (UNEP, 2011; Zabbey and Uyi, 2014).

Spilled oil is reported to have contaminated food chains and life-supporting ecosystems such as rivers and streams, mangrove ecosystems (Fig. 2) and fish ponds (Fig. 3), making oil spill a major concern to local communities (Chinweze et al., 2012). This deprives the impacted people of environmental benefits, including cultural and spiritual practices (Fentiman and Zabbey, 2015). Consequently, ecosystem services such as timber production, breeding areas for fish, mangrove forest are apparently declining in the region (Feka and Morrison, 2017; Fig. 2). Oil related land contamination is also capable of having many impacts (such as cancer, birth defects, genetic mutation and reproductive defects) on the human population (Heubeck et al., 2003; Leopold et al., 2008; Park and Park, 2010), aside from the impact on ecology, e.g. damage to mangrove forests and wetlands; water pollution (Elum et al., 2016; Inam et al., 2015; John et al., 2016; Zabbey and Uyi, 2014). In extreme instances, oil spill events have been linked to unemployment (Fig. 3) and communal conflict and has been posited as a cause of poverty (Ajayi and Ikporukpo, 2005; UNEP, 2011). Despite the extent of oil pollution in the region, to date, little research has been undertaken on the opportunities presented by consequent clean-up and remediation of contaminated environments in the Niger Delta region (Sam et al., 2017a; UNEP, 2011).

As a result of protests and outrage from local communities, the media and non-governmental organisations, the Nigerian Government commissioned the United Nations Environment Programme (UNEP) to conduct environmental assessment of a section of the Niger Delta – Ogoniland (UNEP, 2011; Fig. 2). The Shell Petroleum and Development Company of Nigeria (SPDC), the main oil extraction operator in Ogoni funded the study. The seminal report released by UNEP recommended that more research needs to be urgently done on the development and adoption of mitigation strategies to manage oil spill and prevent new incidents of contamination in Ogoniland (UNEP, 2011).

Primarily, UNEP recommended a comprehensive clean-up and restoration of contaminated sites in Ogoniland to enable the local communities to live a 'quality' life. In addition to other recommendations, UNEP presented an overview of different oil-contaminated sites remediation techniques that are potentially appropriate for the clean-up of Ogoniland. Evidently, most studies have recommended bioremediation as the likely appropriate technique (Zabbey et al., 2017). However, heightened local communities' expectation from the clean-up process has received little or no attention since the launch of the clean-up exercise –a recipe for conflict in the remediation process. There is yet no study to demonstrate how the clean-up could bring about sustainable development and benefit local communities. This study focuses on sustainable job creation through remediation of polluted sites in Ogoniland. It is noted that sustainable job creation requires legislation/regulatory backing given the plausible change in government administration in Nigeria after every four years. For instance, a change in

Fig. 2. Extensive mangrove area in Bodo Creek destroyed by oil spills.

government could lead to jettisoning the clean-up exercise initiated by the current administration. Thus, deliberate policy backed by legislation is necessary for sustainable, long-term remediation exercises aimed at job creation. In addition, the study proposed strategies and roadmaps that would translate the clean-up project into sustainable development (e.g. job creation) and presents opportunities for skill acquisition and the application of the skills in the communities beyond the clean-up in Ogoniland.

1.1. Regulatory history of oil contaminated sites in Nigeria

The history of contaminated land regulation in Nigeria can be categorised into three stages; (1) a stage of no legislation; (2) a stage of non-specific legislation; (3) a stage of specific legislation (Fig. 5). The first stage, a period of no legislation (1956–1968), coincided with the start of oil exploitation (1956), regional management of the sector (1956–1959), and Nigerian Independence (1960) and civil war (1967–1970). During this period there were no regulations in place to manage contaminated land, nor were there any legal instruments in place to prevent contamination (Anago, 2002; Ogbodo, 2009).

In response to increased environmental pollution as a result of oil spills Nigeria began to develop piecemeal legislation to manage the environment (Ajayi and Ikporukpo, 2005; UNEP, 2011). This marked the beginning of the stage of non-specific legislation (1969–2001). During this period the Petroleum Act (1969) was developed which served as an umbrella legislation that made reference to the prevention of environmental pollution in different environmental media including water, air and soil. Multiple legislations, such as the Harmful Waste Act 1988, and the Environmental Impact Assessment Act 1992, were also established within this period, however, these were not designed specifically for the management of contaminated land (Sam et al., 2017b).

As oil production increased, so too did the incidence of oil pollution (Osaghae, 1995; UNEP, 2011), which resulted in an increase in community protests, specifically in Ogoniland (Ajayi and Ikporukpo, 2005). In response to this crisis the Nigerian Government developed the

Fig. 3. Contamination of fish ponds led to economic hardship in Ogoni.

Environmental Guidelines and Standards for the Petroleum Industry in Nigeria (EGASPIN) in 2002. The EGASPIN regulation describes guidelines for environmental quality control, oil exploration, production operations, hydrocarbon processing, transportation, permits, sanctions, and pollution abatement technologies (DPR, 2002). Specific to contaminated land, the EGASPIN provides a set of guidance that aims to mitigate the risks of contaminated land to human health and ecological systems. The introduction of EGASPIN marked the stage of specific contaminated land management legislation (2002–present), which comprises legislation that forms the regulatory basis of the current environmental management mandate in Nigeria. However, the EGASPIN is still inadequate to address the plethora of issues associated with land contamination in the Niger Delta (Table 1). For example, the EGASPIN does not provide free access to contaminated land information and lacks a requirement to undertake sustainability appraisal. Many of the guidelines for environmental quality standards have been largely adopted from other countries (mainly from Dutch values). This is because Nigeria still lacks technical expertise to develop suitable guidelines for managing the oil and gas industry (Ajayi and Ikporukpo, 2005). Of the guidelines in place, there remains a concern that they lack contextualised site-specific risk assessment considerations (e.g. land use, soil type, texture and soil total organic carbon), which could have an impact on operational efficacy (UNEP, 2011). The development of Niger Delta specific Tier 1 Risk Based Screening Levels (RBSLs) could provide an appropriate guideline for Target and Intervention values in the region.

1.2. Contaminated land regulatory authorities in Nigeria

Environmental management is the responsibility of numerous government departments and agencies at the federal, state, and local levels (Sam et al., 2017b). At the federal and regional levels three agencies have the responsibility to manage contaminated environment. They are the Department of Petroleum Resources (DPR), the National Oil Spill Detection and Response Agency (NOSDRA), and more recently, the Hydrocarbon Pollution Remediation Project (HYPREP). The DPR is responsible for granting of license to industry operators, collect revenue and also ensure compliance to contaminated land management regulation – EGASPIN. NOSDRA is mandated to inspect, detect and respond to oil spills (essentially an emergency response agency) within the Nigerian environment. HYPREP on the other hand is a special project under the Federal Ministry of Environment mandated to implement recommendations of the UNEP report on Ogoniland and to remediate other polluted sites in the Niger Delta region (Sam et al., 2017b, 2015). While HYPREP is relatively new and struggling to create its own role, operational policies and capacity, confounding factors seem to have affected the Ogoniland clean up project implementation. These include ministerial bureaucracy, inter-agency overlap, the need to achieve robust stakeholder involvement and community ownership. Additionally, HYPREP's slow pace of designing work plan, obtaining approvals and release of requisite operational funds pose challenges to the Ogoni clean up exercise. The Integrated Contaminated Soil Management Centre (ICSMC), a key soil management resource recommended as a necessity for the Ogoniland clean up and remediation is still at the design stage.

However, the environmental management agencies' roles often conflict. For example, when an oil spill occurs the operator must notify DPR and NOSDRA, each of which will then initiate an independent risk assessment of the site (Sam et al., 2017b, 2015). Conflict might thus arise from different assessments, which could impact the legitimacy of the management recommendations provided by NOSDRA who has the mandate to address new spills. This potential lack of synergy is now a real concern given that HYPREP also has a special mandate to clean-up and remediate polluted sites in Ogoniland and the wider Niger Delta while the NOSDRA Act 2006 empowers NOSDRA to prevent, detect and clean up oil spills throughout Nigeria. Conflict might occur between NOSDRA and HYPREP considering that no adequate delineation has been provided, and both agencies are independent of each other – no one supervises the other and there is likely to be competition between the agencies to prove which is most effective or influential. Overlap will ultimately lead to inefficiencies in governance, such as double budgeting for management of contaminated sites, and conflicting standards (Okotoni, 2004).

2. Remediation approaches for oil-related contaminated land and coastal environment

Remediation is the process of dealing with contaminated soil, groundwater, or site to eliminate or control risks to human health or the environment (International Organization for Standardization, 2018). More specific to this study, sustainable remediation involves processes to eliminate and/or control unacceptable risks in a safe and timely manner while optimising the environmental, social and economic values of the work (International Organization for Standardization, 2018; Nathanail et al., 2017). Various techniques exist for remediation depending on the media (e.g. air, water, or soil) (Rosén et al., 2015). Remediation could be achieved through phytoremediation or bioremediation processes. Phytoremediation involves the use of living green plants or their roots to fix or absorb contaminants from soil. This approach uses enzymes present in plant roots to aid degradation of contaminants. It reduces contaminant concentration in soil and consequently reduces risk posed by such contaminants to the environment and human health. For example, Peng et al. (2009) used *Mirabilis jalapa* L. to remove 63.2% of petroleum from contaminated soil. Bioremediation is an approach that facilitates the natural biodegradation process of hydrocarbons through the provision of

Table 1
Main legislation relating to contaminated land, and relevant areas (Sam et al., 2016).

Legislation	Prevention	Protection of human health and the environment	Management	Access to information	Sustainability appraisal
The Petroleum Act 1969					
Federal Environmental Protection Act 1988					
Harmful Waste Act 1988					
National Policy on Environment 1989					
Oil Pollution Act 1990					
National Environmental Protection (Abatement in Industries Generating Wastes) Regulation 1991					
National Environmental Protection (Effluent limitation) Regulation 1991					
Environmental Impact Assessment 1992					
Constitution of the Federal Republic of Nigeria 1999					
Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN) 2002					

nutrients and oxygen required by soil microbes (Lim et al., 2016). The UNEP (2011) study on Ogoniland identified current technologies in contaminated land remediation. However, many of the remediation approaches outlined, for example, containment, air stripping, fixation and incineration, could leave environmental footprints (Hou et al., 2014; Hou and Al-Tabbaa, 2014), deny access to land for agriculture and accelerate greenhouse gas emissions (Hou et al., 2014; Hou and Al-Tabbaa, 2014). In addition, while physical methods principally involve soil replacement and thermal desorption, the method is labour intensive, expensive and only suitable for small contaminated sites (Khan et al., 2004). This implies it could be unsuitable for the large-scale contamination in the Niger Delta region. On the other hand, chemical methods involve washing contaminated soil using clean water, reagents, solvents that can leach the contaminants from the soil (see Hamby, 1996; Yao et al., 2012; Lim et al., 2016). This method could be achieved through chemical leaching, chemical fixation, electrokinetic remediation, vitrification technology, chemical immobilisation, oxidation, chemical fluid extraction and photodegradation, among others. Chemical methods are expensive and have the potential to contaminate other environmental media including air and water bodies through the introduction of solvents and reagents during remediation (Yao et al., 2012). Specifically, this approach is fast at cleaning up contaminants, however, harmful wastes generated in the process include carbon dioxide and other greenhouse gases which are emitted into the surrounding environment (Cappuyns, 2013).

Cautiously, ancillary and secondary environmental impacts resulting from remediation technologies should be considered in order not to create more problems in the process of solving one. Zabbey et al. (2017) demonstrated the feasibility of remediating contaminated sites in the Niger Delta using successful case studies from coastal environments with similar physicochemical and geomorphological characteristics.

The analysed case studies in Zabbey et al. (2017) and evidence from other studies conducted in/and similar to the Niger Delta including those of Wang et al. (2016), Abdulsalam et al. (2011), Adams et al. (2017), Rizzo et al. (2016), and Brown et al. (2017) demonstrated the efficacy of bioremediation to achieving remediation in coastal environments. In addition, following UNEP (2011) recommendations for Ogoniland remediation, the International Union for Conservation of Nature (IUCN) in collaboration with SPDC established in 2012 an independent scientific advisory panel (i.e. the Niger Delta panel), to assess the best approach for remediating and rehabilitating the Niger Delta polluted environments. The Niger Delta Panel broadly recommended the use of biological methods for remediation of polluted sites in the region (IUCN, 2018). This suggests that the prospects for contaminated land clean-up in the Niger Delta region could benefit from technology adopted in environments with a similar physical nature of impacts and chemical structure of contaminants (Brown et al., 2017; Wang et al., 2016). Bioremediation is economically viable and socially acceptable (Nathanail et al., 2017). It will create jobs and allow access to farmlands, and leave behind environmentally safe legacy as a result of reduced greenhouse gas emission.

Given the different remediation technologies, the physical and chemical characteristics of the Ogoni environment and sustainable livelihood needs of the Ogoni people, studies have identified bioremediation as the technology that will integrate social dimensions and deliver overall benefits to the local communities in terms of environmental value, socio-economic prosperity and opportunities for livelihood (Bardos et al., 2016; Harclerode et al., 2015; Zabbey et al., 2017). Applying the principle of returning net benefit to local communities in remediation projects would boost the local economy and enhance ownership of such projects by communities (Bardos et al., 2011; Hou and Al-Tabbaa, 2014). The following sections highlight opportunities for the creation of sustainable livelihood in the Niger Delta during the Ogoniland clean-up exercise. While we agree with Zabbey et al. (2017) on the appropriateness and efficacy of bioremediation, it is important to highlight the importance of combining different remediation technologies depending on various factors such as concentrations and composition of the contaminants, and the ecosystem and land use nearby.

3. Land and coastal remediation and opportunities for job creation

Primarily, the clean-up is expected to remediate polluted sites in Ogoni. However, given the time scale and the amount of money to be expended in the remediation process, the project is expected to support existing jobs and businesses, create new ones in local communities in Ogoni, and to have a knock-on effect in other communities in the Niger Delta region. The clean-up of Ogoniland should enable smart, sustainable and inclusive economic growth. This means developing, adapting and adopting mechanisms or models (as the Contaminated Land: Applications in Real Environments (CL:AIRE, 2010), that will create and encourage creation of long-term, and skills-developing opportunities for the communities and further ensue, facilitate and support economic prosperity in the communities. With the public demand for immediate remediation in impacted communities, there are possibilities that HYPREP might want to skip certain steps, e.g. training of local communities in different skills that might be needed during remediation. While the public-pressure-driver short cut is compelling, a robust framework/model that integrates inputs across all stakeholders (Bardos et al., 2016) would ensure all relevant steps are identified and followed (Ellis and Hadley, 2009; Sam et al., 2016).

This research, having identified bioremediation as a viable approach for the remediation of Ogoniland, considers the value chain and highlights different stages where sustainable jobs would be created. The study considers two routes for sustainable job creation in the remediation process, namely, contaminated land restoration and coastal environment restoration (i.e. mangroves and water ways). While the list for job creation is inexhaustible, it is important to note that the clean-up, remediation and rehabilitation processes are expected to last between 25 and 30 years, and as such, job creation will spread along the value chain of contaminated land management. This would include jobs resulting from long term care of the land, such as renewable energy and feedstocks.

In terms of job creation, it could be challenging to precisely estimate the number of jobs that will be created. This is because of several reasons:

1. The level of contamination in Ogoni is not uniform and would require different scales of clean-up and remediation. The polluted area will be delineated and characterized, if international best practice is the guiding principle. Thus, it is difficult to ascertain at this stage the actual areas that will require different depths of remediation and the type of clean up required.
2. In addition, coastal remediation might involve more processes, equipment and technicalities (and consequently more jobs) than upland clean-up, thereby posing a challenge for precise estimation of jobs that could be created during the clean-up in Ogoni.

However, it is possible to make a generalised projection for job creation in the process of coastal and upland remediation. An indication of the nature and number of jobs that could be created is provided in Tables 2 and 3 for possible extrapolation to the Ogoni case pending delineation and identification of the level of contamination on each site to be remediated, and informed choice of the clean-up and remediation approach requisite for each delineated site.

For the purpose of identifying the different jobs that could be created during the remediation, the authors segmented the remediation process into land and coastal remediation processes. This is to enable a fair and detailed identification of potential jobs, and provide regulatory authorities leeway for areas of training required prior to needs assessment.

Table 2
Land contamination clean-up activities, requirements and possible job creation opportunities.

Activity	Description	Resources required	Type of job	Number of jobs	Impacts on local communities
Raw materials	Chemicals and consumables that will be used in the remediation process	Industrial traders, labourers and artisans	Unskilled	Although dependent on length, speed and type of clean-up. Several persons are required to supply bioremediation products (e.g. kanaf, IUCN, 2018; Brown et al., 2017).	Local economy will improve due to involvement of community members in production of kanaf. More petty traders being patronised.
Transport	The movement of equipment and raw materials from source to where they are needed.	Local drivers	Skilled	This is dependent on the number of sites and workforce. Both private and commercial drivers are required.	More unemployed or underemployed youths will be engaged for the period of remediation and beyond
Application	The implementation of remediation technologies on site	Geologists, hydrogeologists, engineers, environmental scientists, biologists, ecologists, etc.	Skilled	The application process will require teams of professionals which should include industry, regulatory and local experts. This has opportunities for collaboration, partnership and knowledge sharing. A team is made up of a driver and 3–6 persons (experts) per boat.	Different experts will be engaged with knock-on effect in the local community. One employed expert could lead to more employment e.g. drivers.
Waste storage and treatment	The storage and treatment of waste to remove hazardous components before disposal.	Storage tanks, trainings and land resources	Skilled and unskilled	Apart from the ICSMC that will be situated at Bori, the process will require trucks (or mobile waste treatment plants), drivers and assistant, and hazardous experts. Extensive training on handling of waste and storage is required. In addition, equipment hire and land resources for storage of waste and landfill will be a source of employment and income for the Ogoni people.	This will create jobs for the unskilled and skilled in the communities. More importantly it will include trainings on manual handling of hazardous waste which could be applied in other fields outside the present clean-up
Disposal	The evacuation of waste from site	Experts on hazardous waste disposal. Land resources to serve as landfills	Skilled	A team of waste disposal experts. Drivers, Driver and 1 to 2 persons per truck. At least 10 trucks required. 5 persons crew required for decontamination of equipment.	Acquisition of land at designated areas will lead to economic prosperity in the community.
Recycling	Changing the form or state of waste to make them reusable	Recycling plants, land resources experts and unskilled labour. Construction of the ICSMC.	Skilled and unskilled	This is dependent on the volume of waste and speed of recycling. It will require a significant number of unskilled labour. Skilled personnel will be required for the ICSMC	The local people will be engaged for skilled and unskilled services. This would increase economic activities with associated ripple effect in the communities. For example, the ICSMC will require construction and site maintenance work – this will require skilled (mostly analytical) and unskilled (labourers) personnel from the communities.

In general, the clean-up activities in both upland and coastal environments should begin with different preliminary tasks. Project planning depends mainly on the tasks. These tasks which include the clean-up guidelines will form the basis for a well-conceived, effective and efficient restoration design for Ogoniland.

3.1. Contaminated land restoration and sustainable job creation

Although this study already identified the significance of a combination of remediation approaches, as mentioned above and argued elsewhere (Zabbey et al., 2017), bioremediation is considered the primary remediation approach for Ogoniland. Thus, the model considered for job creation is fundamentally based on the processes and value chain of bioremediation technology.

Contaminated land remediation will require different stages as described in Table 2. At different stages of the remediation process – given the remediation value chain opportunities for job creation and possible impact on the local community are highlighted.

3.2. Coastal restoration and sustainable job creation

Coastal environment restoration is widely acknowledged as one of the major mechanisms to achieve development particularly in a region where the local communities is comprised of farmers and fisher folks, such as Ogoniland. This is because one of the reasons for the emergence of coastal destruction by obnoxious practices such as artisanal oil refining (Fig. 4) is economic structural change and the decline of traditional industries. Coastal contamination leads to decline in fish populations, death or deterioration of mangrove habitat, which leads to job losses (UNEP, 2011).

3.3. Opportunities for sustainable livelihood during and post remediation

As a result of the long-term oil contamination in Ogoni which has impacted the coastal environment and upland regions, fishing and farming activities have declined tremendously. Thus, farmers resort to the use of inorganic fertilizers to improve crop production. The Niger Delta is characterized by high precipitation, making the region one of the wettest areas in the world. Most of the inorganic fertilizers are washed by run-off into surface waters causing eutrophication and algal bloom. Similarly, the local population now depend mainly on imported fish (locally described as iced fish) as fishing is no longer economically viable (not even for subsistence purposes) (Pegg and Zabbey, 2013) in the area as a result of hydrocarbon polluted waterways and degraded mangroves.

Given the challenges experienced primarily by farmers and fisher folks in Ogoniland, this study proposed two models - one each for upland and coastal restoration, highlighting opportunities for sustainable livelihood in Ogoniland that will outlive the clean up and restoration activities. The study is mindful of possible changes to land use during and after remediation. While this might affect land owners (e.g. putting land to other appropriate uses), it is assumed that skills acquired during the remediation process would be applied beyond the region – as a sustainable livelihood tool.

Table 3
Coastal clean-up activities, requirements and possible job creation opportunities.

Activity	Description	Resources required	Type of job	Number of jobs	Impacts on local communities
Develop a clean-up framework	A policy document that details what is expected in terms of coastal remediation goals and purpose	Highly experienced experts which might include hydro-biologist, plant ecologist, geologist, hydrobiologist, restoration ecologist, GIS experts, regulatory authorities and other expertise.	Skilled	A team of experts that will Shoreline Clean-up Assessment Technique (SCAT), which will include community members and industry operators. A minimum of 8 experts.	While this document will provide a direction for coastal remediation, it will assure the local communities of government sincerity and build trust among different stakeholders.
Protection of mangroves	The protection of existing coastal environment from new spills and encroachment	Local communities will produce the labour required for protection	Skilled	This will require the local community members. They should be trained and certified for this purpose.	This will help divert the attention of local community members from social vices as they become preoccupied with securing the mangrove area. This will also create sustainable opportunity post restoration as certified community members could work elsewhere with the certificates and experience.
Shoreline Clean-up Assessment 4Technique (SCAT)	An evaluation of innovative techniques to define and identify appropriate clean-up techniques for the Ogoni coastal zone (NOAA, 2013).	SCAT personnel are experienced environmentalist with seasoned expertise in coastal remediation. SCAT equipment will also be required.	Skilled and unskilled	The number of SCAT teams placed in the field is dependent on scope of clean-up activities. Specialized technical personnel will be required, particularly regarding bioremediation and mangrove planting. Dedicated field teams will be required to undertake testing and verification that the techniques are working.	The local population might not have sufficient expertise for this task. However, training of locals with remediation experience will enhance knowledge exchange and sharing and facilitate partnership and networking. In addition, locals can venture into hiring services (e.g. hire SCAT equipment to experts). This will stimulate economic activities within the local communities.
Control, recovery and removal of free floating oil	Floating oil (black oil and sheen) needs to be controlled, recovered and removed from the water ways in Ogoni	Experts knowledgeable in wind direction and tidal movement is required. Equipment such as shallow draft, safety gear, flat bottom work boat and boom deployment and maintenance.	Skilled	A team is made up of a boat driver and 3–6 persons (experts) per boat. For a 2200 ha of waterways, at least 6 teams are required. Clean-up of free floating oil is required at certain locations throughout Ogoni coastal area.	This activity will require transport boats which can be provided by the local communities at certain rates. Drivers alongside the services of experts will also be required. Thus, the removal of floating oil will require expertise and logistical services from the community members.
Clean-up of hard substrate	Hard surfaces such as mangrove peaty soil and sandy mud that can sustain workers on site or certain equipment. It could involve barge or work platform to deliver small equipment (pumps, skimmer, storage, etc.)	Light equipment and coastal remediation experts.	Skilled	A driver and 3 to 6 persons per boat are required. At least 6 boats for an area between 50 and 100 ha. Work platform requires a boat driver and assistant. At least 4 work platforms required for a start. This requirement is also needed for barge. On site decontamination requires 3 to 5 persons per crew.	This will involve the local community members whom will be trained for this purpose. It will therefore create jobs for the teaming youths and boat drivers which will hitherto enhance the economic prosperity of the local communities.
Clean-up of fish ponds	The remediation of privately owned coastal fish ponds	This will require the expertise of experienced remediation experts	Skilled	Driver and 3 to 6 persons per boat. For low pressure wands with pump system to release surface oil about 5 to 10 per work site, each with a worker. A 2 person crew required for decontamination of equipment.	Although this report has proposed an alternative to the conventional fishponds in mangrove swamps (see below), in the interim, the restoration of fish ponds will rejuvenate fishery business in Ogoni and restore opportunities for sustainable livelihood.
Clean-up of former artisanal refining sites	The remediation of sites that were formerly used to illegally refine petroleum product. This could involve movement of heavy oil to a central treatment area and on onsite decontamination of equipment.	Shallow draft boats, drivers, flat bottom work boats, barge, heavy equipment, and/or onsite decontamination equipment, small bulldozer/excavator etc.	Skilled	This starts immediately with aerial surveillance support. For movement of heavy oil to treatment area, 10 to 30 persons crew are needed for each site depending on site requirement. 1 site supervisor 1 team leader for each work crew. Number of teams will be dependent on number of sites.	The clean-up of former artisanal refinery sites should involve the community members who can use this skill to seek employment post restoration.
Remediation of channels > 10 m. Channels < 10 m	Clean-up of oil along water channels/creeks within Ogoniland.	Sorbents, work boats, boom, safety gear, and on site decontamination equipment.	Skilled	100 to 500 m of shoreline can likely be completed daily depending on width of the contaminated shore. Driver and 3 to 6 persons per boat. Barge mounted, low-pressure flushing system, with push boat requires 5 persons	Channels link rivers which are used as sources of drinking and washing water in the area. Remediating the channels will improve the quality of water accessed and utilised by the local communities for their daily needs.

Table 3 (*continued*)

Activity	Description	Resources required	Type of job	Number of jobs	Impacts on local communities
				per crew. 2-person crew required for decontamination of equipment. Two or more boats may be required per creek depending on the amount of oil and difficulty to access the area to mobilise and capture oil –driver and 3 to 6 persons per boat.	
Clean-up of areas with soft tidal flats and dead mangroves	This is the remediation of areas where mangroves had existed but are now dead.	Work boats, work plan, and SCAT field studies.	Skilled	This is the most challenging to remediate. A work plan and schedule is dependent on SCAT field studies and recommendations, and cannot be provided at this time.	The clean-up of soft mudflat requires special skills. Thus, personnel training which will involve community members is needed.
Consider planting as part of clean-up	This is the planting of mangrove propagules (seedlings) having completed the clean-up and remediation in the mangrove areas. Mangrove planting can also be done without clean up at sites having volunteer mangrove seedlings to achieve net environment benefits.	Seedling, nursery, site characterization especially hydrology, sediment analysis, swamp elevation measurement and transportation	Skilled and unskilled	This will require a team of experts knowledgeable in mangrove restoration ecology and should include community youth members, industry operators and, in rare cases foreign expertise.	Mangrove planting will require extensive involvement of the local people whom will be trained in the process and empower the people.
Other considerations to be made	This describes other activities that support clean-up operations and should not be overlooked e.g. waste storage and equipment decontamination activities, safety culture and first aid/mobile clinic.	Decontamination solutions, experts, boats and other equipment.	Skilled	A team of experts with specialty in hydrocarbon waste management, safety officers, site nurses and a doctor for safety briefings/checks to minimize work site injury, emergency treatment and decontamination.	There are other supporting activities which will require the services of the local communities and result in economic prosperity in the Ogoniland such as local monitoring of planted mangroves

3.4. Sustainable livelihood opportunities and coastal environment restoration

Several opportunities exist for sustainable livelihood post restoration of the coastal environment (Fig. 7). The use of fish pen and cage structures for fish culture in the sub-tidal waterways rather than the conventional fishpond could benefit the local population. According to Zabbey et al. (2014), fish pen and cage culture could protect the integrity of the mangroves to continue to deploy their inherent goods and services (e.g. habitat for fish breeding) for the overall maintenance and productivity of the seascape. Conventional pond construction in mangrove areas involves removal of mangrove cover and excavation of the peaty sediment to create the ponds and build the embankments. The fish pen culture can only be established having successfully remediated the coastal environment including the mangroves, and preventing re-pollution. These fish culture structures (pens and cages) could serve as sustainable livelihood (direct and indirect jobs) for hundreds of local people in Ogoni.

Fig. 4. Abandoned artisanal oil refining site with tarred impact.

Similarly, many families in Ogoni and particularly women are dependent on periwinkle picking from the intertidal mud flats. This activity has been a livelihood for the local communities particularly women over the years. However, oil spills and consequent disappearance of periwinkles limit this benefit. The remediation of the coastal environment will restore this livelihood and empower women in the local communities. In addition, other fishing activities including harvesting oysters, bloody cockle, and mangrove crabs (e.g. swimming crab, purple hairy crab) will resume and restore the traditional livelihood of the local population Rejuvenated fishing activities could provide jobs for hundreds of local community members post restoration.

In terms of mangrove restoration, breeding areas for fishes and other mangrove ecological services including shore protection, flood control and maintenance of water quality will be restored (Ronnback, 1999; Rönnbäck et al., 2007). This has the potential to significantly reduce budgetary allocations for coastal protection by government. Such funds could be diverted to other development projects in the communities that will enhance local industries. For example, dependable electricity supply would encourage local production of ice blocks needed by fishmongers to preserve fresh fish against spoilage. This would also reduce the lamentable dependence on diesel-fuelled electricity generators throughout the region, that add to the pollutant loading.

3.5. Sustainable opportunities and upland remediation

Remediation of extensive farmlands polluted by hydrocarbons will restore fertile soil for agricultural activities in Ogoniland. Due to contaminated soil, agricultural soil has declined in fertility. Studies have shown that hydrocarbon contamination in Ogoniland has led to a decline in soil quality, as determined by a reduction of microbial activity, and agricultural yields (Oyebamiji and Mba, 2013). The local population relies on subsistence farming for their economic survival (Omeire et al., 2014; NDDC, 2014; Elum et al., 2016). Fig. 5 shows a sustainable livelihood model proposed to succeed upland clean-up in Ogoni. (See Fig. 8.)

Successful upland remediation will restore fertile soil for farming and consequent improved agricultural yield. Thus cash crops and garden crops will be cultivated for subsistence and sold for income. This will be a significant relief for thousands of local farmers who depend on farming as a source of livelihood. In the long-term resources budgeted for fertilizers will be channelled towards other development ventures for the overall benefit of the local communities. In addition, improved aquifers, surface waters and air quality will improve the quality of life in the area. While existing contaminated sites will also be restored for residential and industrial purposes, 'brown field' development avoids use of 'green field' sites that should be left as forest or farmland. Upland remediation will safeguard public health and reduce efforts and resources expended on health issues related to hydrocarbon contamination.

3.6. Forming cooperatives for natural resource management

While there are functioning fishermen's associations in Ogoni communities, women periwinkle pickers are not organised into unions (Zabbey et al., 2014). The lack of established associations and representative platforms, together with cultural barriers make women's participation in local natural resources governance and decision-making processes grossly inadequate. Similarly, there are no functional farmers' associations to galvanise the activities of farmers in the area. To help establish inclusive governance systems and participatory decision-making processes, it is imperative to form cooperative associations.

Cooperative associations with democratic and accountable leadership will deliver several benefits to the local communities. For example, the leadership of the women's associations will be able to engage and interface with HYPREP and development bodies for support and capacity-building of their members (e.g. via extension programmes). Such associations could serve as platforms to reduce the activities of middlemen and consequently the barriers created by the latter. Thus, cooperatives will foster unity among members and improve farm gate prices for rural food products – which can increase income, enhance output value, and adequate flow of market information and extension education.

Cooperative platforms can serve as avenues for creating awareness on land contamination and its consequences on local communities. Such platforms are thus mechanisms for natural resource management in Ogoni, which will complement government efforts at reducing land contamination.

In the following sub-sections, the study explores additional opportunities for sustainable livelihood in Ogoniland. The study discusses the possible impacts of training, partnerships and knock-on and/or multiple effects of the remediation project in Ogoniland.

3.7. Trainings

As a result of extensive contamination of the terrestrial and coastal environment in Ogoni, the number of livelihoods involved, and the period required for successful clean-up of Ogoni, UNEP (2011) recommended the establishment of a centre of excellence for environmental restoration in Ogoniland. The Ogoni clean-up and remediation will involve series of trainings that will translate into sustainable livelihood for the local population and neighbouring communities. For example, waste storage and treatment, post clean-up follow-up and monitoring, and staffing of the centre of excellence for environmental restoration and the ICSMC will require skilled personnel. Recently (March 2018),

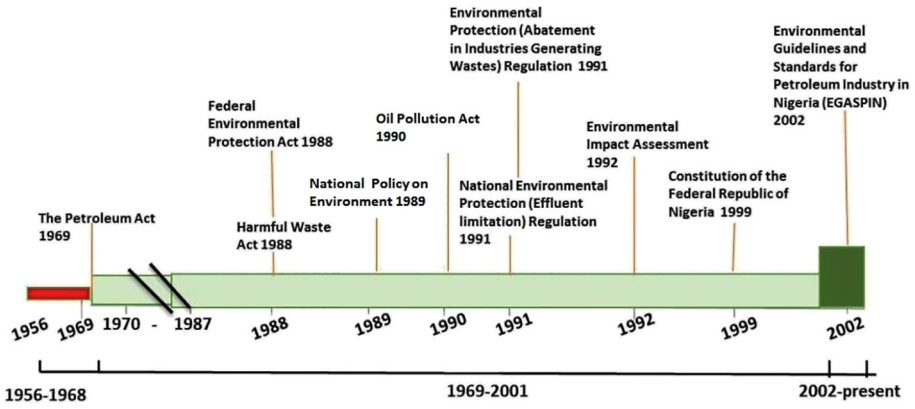
Environmental Protection (Abatement in Industries Generating Wastes) Regulation 1991
Environmental Guidelines and Standards for Petroleum Industry in Nigeria (EGASPIN) 2002
Federal Environmental Protection Act 1988
Oil Pollution Act 1990
Environmental Impact Assessment 1992
National Policy on Environment 1989
National Environmental Protection (Effluent limitation) Regulation 1991
Constitution of the Federal Republic of Nigeria 1999
The Petroleum Act 1969
Harmful Waste Act 1988
1956 1969 1970 - 1987 1988 1989 1990 1991 1992 1999 2002
1956-1968
1969-2001
2002-present

Fig. 5. Timeline presenting the development of contaminated land management policy in Nigeria from 1956 to present (Sam et al., 2017b). Red – period of no legislation; Light green - period of non-specific legislation; Green – period of specific legislation.

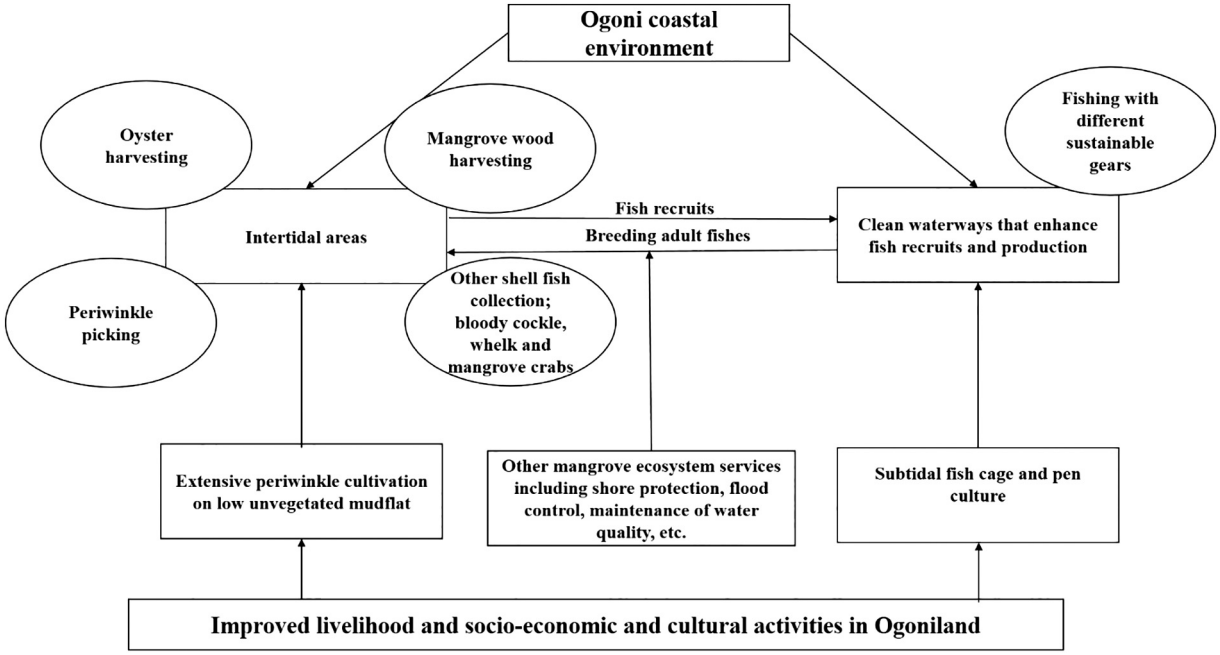
Ogoni coastal environment
Oyster harvesting
Mangrove wood harvesting
Fishing with different sustainable gears
Intertidal areas
Fish recruits
Breeding adult fishes
Clean waterways that enhance fish recruits and production
Periwinkle picking
Other shell fish collection; bloody cockle, whelk and mangrove crabs
Extensive periwinkle cultivation on low unvegetated mudflat
Other mangrove ecosystem services including shore protection, flood control, maintenance of water quality, etc.
Subtidal fish cage and pen culture
Improved livelihood and socio-economic and cultural activities in Ogoniland

Fig. 7. Opportunities for sustainable livelihood post restoration of Ogoni coastal environment. (Modified from Zabbey et al., 2014)

the Rivers State Government appointed a committee to explore the feasibility of converting the Ken Saro-Wiwa Polytechnic in Bori, Ogoniland to a specialized University for Environmental Studies. The centre of excellence is expected to run environmental courses with the aspiration of becoming a world leader in oil remediation in tropical environments. The centre is expected to make global impact, promoting learning within and beyond Ogoni. To achieve this, different expertise and professionals will be required, thus, high-level trainings, collaborations and partnership will be required for the institution to operate successfully. It is therefore imperative to undertake trainings that will enhance the capacity and skills of Ogoni people. To ensure such trainings are sustainable, it should involve certification courses, e.g. the International Maritime Organisation (IMO) - an international maritime agency that conducts training for oil spill response, inspection, and certification and quality assurance. Such trainings will help the local communities acquire transferable skills that could be used to secure jobs beyond the clean-up in Ogoniland. For example, HYPREP plans to train over 2000 women from the four local government councils of Ogoni in various skills (including snail farming, palm oil processing, and pottery) that will enable them to be financially independent.

3.8. Partnership and knowledge sharing

Stemming from the range of different trainings that will be required, foreign experts will probably be involved. This is obvious as the local communities do not possess all the skills required for effective clean-

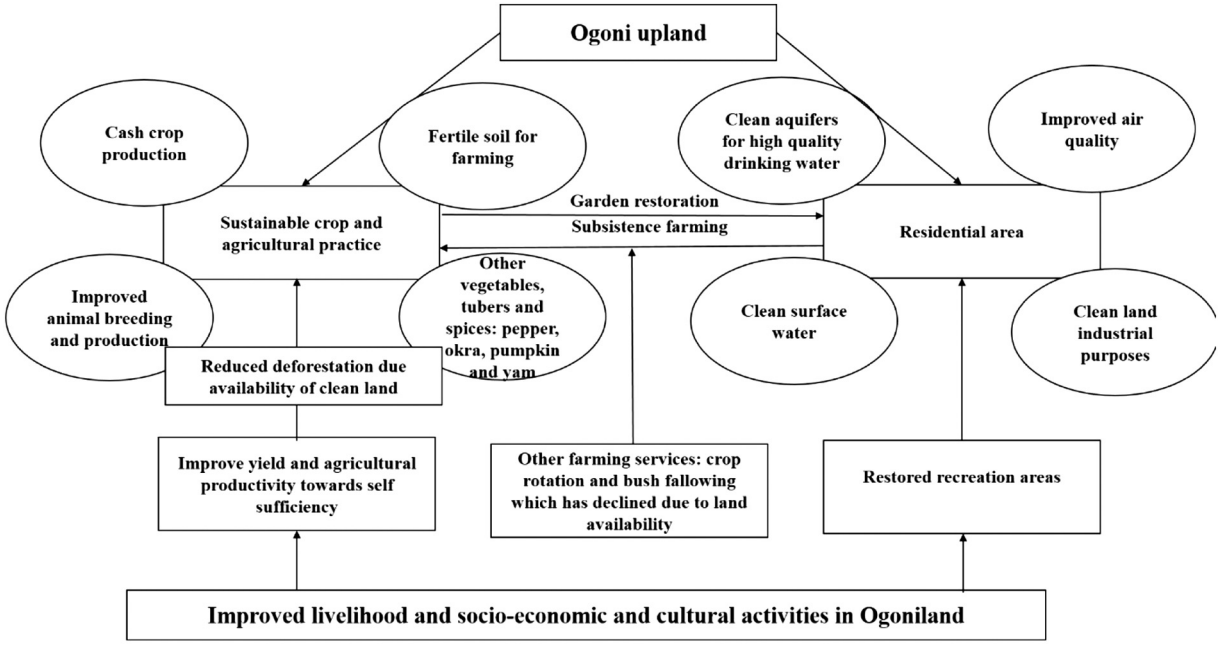
Ogoni upland
Cash crop production
Fertile soil for farming
Clean aquifers for high quality drinking water
Improved air quality
Garden restoration
Subsistence farming
Sustainable crop and agricultural practice
Residential area
Improved animal breeding and production
Other vegetables, tubers and spices: pepper, okra, pumpkin and yam
Clean surface water
Clean land industrial purposes
Reduced deforestation due availability of clean land
Improve yield and agricultural productivity towards self sufficiency
Other farming services: crop rotation and bush fallowing which has declined due to land availability
Restored recreation areas
Improved livelihood and socio-economic and cultural activities in Ogoniland

Fig. 8. Opportunities for sustainable livelihood post upland restoration in Ogoni.

up (UNEP, 2011). Thus, partnership will lead to network building, information sharing and knowledge transfer. It could be the case that such partnership will result in scientific commerce with other nations.

3.9. Knock-on effects and indirect jobs

For each member of a local community engaged in the clean-up exercise there would be knock-on effects and creation of indirect jobs. For example, the relatives of a labourer employed could have access to funds for petty trading from the labourer. Similarly, petty traders and local service providers will experience economic growth during and after the remediation exercise because of enhanced cash flow. Although there are concerns over the sustainability of the petty traders after the remediation exercise, diversification of proceeds from the remediation into other ventures could sustain and diversify economic growth.

4. Roles for industry, national and international actors for the successful completion of the remediation exercise

Sustainable land contamination management requires concerted efforts of all stakeholders. Specifically within the Niger Delta, the different contaminated land management stakeholders including the government/regulator, oil industry operators, and the local communities have different roles to play to ensure effective and sustainable contaminated land management. These roles include legal backing for the remediation exercise, management of stakeholders' expectations, trust fund and inclusive participation, among others. For example, the Ogoniland remediation is currently not backed by law and is thus vulnerable to shortage of funds, particularly when there is change in government administrations. Increased agitation from local communities following non-inclusive decision-making by policy makers might impede the success of the remediation. Thus, all stakeholders should be coordinated to participate in the exercise and contribute to a successful remediation. In the following subsections, we explained the different roles to be played by all stakeholders.

4.1. Legislate the clean-up of Ogoniland

The seminal UNEP report suggested that the clean-up of Ogoniland could take up to 30 years to achieve successful restoration of hydrocarbon contaminated sites (UNEP, 2011). Hence, the clean-up process will span through several government administrations before completion. It is very likely that the policy goals of different government administration might differ and such variations might affect the clean-up (e.g. provision of funds for the clean-up). It is therefore imperative for government to institutionalise the Ogoni clean-up with legislation. Profiling HYPREP in a Gazette is insufficient to ensure sustainability; government should demonstrate seriousness to implement the UNEP recommendations by developing requisite laws to underpin the process. Thus, there is need for a comprehensive environmental protection legislation that will ensure environmental responsibility and sustainability during and beyond the clean-up exercise.

Integrated legislation will allow the consideration of the total environment, which includes soil, water, and air to ensure that residual contamination of the biota and consequent risk to human health resulting from the decontamination process is addressed. In addition, pollution of soil, surface water and ground water are closely linked and it is essential to consider them simultaneously. Therefore, an integrated approach supported by a comprehensive policy will ensure all spheres are considered simultaneously.

4.2. Establishment of a trust fund for HYPREP's financial autonomy

Clean-up of contaminated sites can be prohibitively expensive and funding is arguably the most important challenge facing contaminated land management in Nigeria (Sam et al., 2017b, 2015; Zabbey et al., 2017). The Nigerian economy recently recovered from recession, which in addition to other competing variables on government agenda, make funding for environmental decontamination a challenge. Sustained funding for government initiated projects is an on-going concern in Nigeria. Despite the take-off investment of 10 million USD provided by the Nigerian Government for the Ogoniland clean-up, it is necessary to develop a sustainable approach to ensure availability of funds for the lifespan of the project. The government can take a cue from the USA who addresses funding challenges through their Superfund mechanism, which transfers funds from the chemical and petroleum industries (as a tax) to clean-up activities. UNEP (2011) and Sam et al. (2017b) recommended a similar approach for Nigeria whereby a percentage of the Excess Crude Account (petroleum royalty scheme) could be assigned to a contaminated land management Trust fund. It is understood that industry operators and the Nigerian government would adopt a contributory approach to fund the clean up. However, for reliability and sustainability of the process, as mentioned above, legislation would insure the funds and ensure sustainability over the projected 30 years period, and beyond.

In addition, following the current remediation, government needs to take stringent measures to prevent further spills. This can be achieved through enforcing legislation based on the polluter pays principle, robust pipeline monitoring using state-of-the-art technology, and prosecution of oil thieves. Such preventive measures are lacking in Nigeria, but exist elsewhere. For example, in the UK and USA, funding of contaminated sites is a function of liability, which is the process of identifying the person or group of persons that have unknowingly or deliberately contaminated land (Luppi et al., 2012; Zhu and Zhao, 2015). In the UK, the polluter pays principle ensures that the liable parties pay for the damage done to the natural environment (EA, 2009), thereby reducing the economic burden of contaminated land remediation on government. The Nigerian government could adopt the polluter pays principle, or assign responsibility to the operator, or the owner of an exploratory license (Nathanail et al., 2013). Regardless, Nigeria could benefit from the adoption of structured approaches for assigning legal responsibilities similar to those used in the UK and USA (Snowden and Ekweozor, 1990). These responsibilities, used in conjunction with insurance mechanisms, could be used to manage contamination as a result of pipeline sabotage or vandalism.

4.3. Pre-spill environmental baseline

An essential element for a successful contaminated land and coastal environmental restoration project is pre-contamination baseline study (Snowden and Ekweozor, 1990; Zabbey and Uyi, 2014). The lack of baseline data affects the quality and validity of conclusions reached both at the end of a restoration project and in post impact assessment (Eniang et al., 2016; Luiselli et al., 2015; Zabbey and Arimoro, 2017). The unavailability of baseline data could be a major challenge for effective and efficient contaminated land restoration of impacted areas of Ogoni. It is reported that certain species of fauna and flora that existed in the pre-disturbance era in Ogoni had been extirpated (Eniang et al., 2016; Luiselli et al., 2015). Where baseline studies that could identify these species are lacking, evaluation of efficient restoration and remediation could be a challenge. In addition, baseline data could indicate the level to which environmental restoration is required which in turn indicates the efforts and resources required for restoration, and the success rate of the restoration (Clewell and Aronson, 2013).

4.4. Local production of bioremediation products

The cost-effectiveness and long-term success of land and coastal remediation activities will require that stakeholders are motivated to participate in and own the exercise. One way to sustain the interest and

motivation of the local communities is to allow the locals to produce bioremediation products (e.g. local production of bioremediation products such as kanaf for bulking agent, biochar as a sorption media) (Deng et al., 2017). Primarily, alternative income opportunities and ability to participate and contribute meaningfully in activities to restore biodiversity and habitats will help address their concerns of neglect In addition, capacity building for local universities and research institutes will open different frontiers of research and development (R & D) opportunities that will benefit the local communities, industry operators and the government (Abbey, 2018). This is expected to encourage economic prosperity in Ogoniland and the Niger Delta at large.

4.5. Consultation and engagement

The lack of effective stakeholder engagement has been identified as the primary reason for protests and conflict in Ogoni (Sam et al., 2016; UNEP, 2011). There is a high level of disengagement between different contaminated land stakeholder groups in Ogoni. For example, while the local population perceive the government to be weak at implementing available policy for strict contaminated land clean-up (Adelana and Adeosun, 2011), oil operators accuse local population of pipeline sabotage, and thus operators decline adequate clean-up of spill sites in such cases (Nzeadibe et al., 2015). As a result, stakeholder groups lack trust and confidence in each other and this affects engagement (Nzeadibe et al., 2015). In turn, conflicts characterize the relationship between stakeholder groups, for example, perennial conflicts between local communities and multinational oil corporations. In such situations, it is difficult for stakeholder groups to engage and jointly discuss mechanisms for ensuring contaminated land remediation. In developed regions, integrated and robust approaches are used to ensure greater stakeholder participation in contaminated land management decision-making process.

For example, the Organisation for Economic Cooperation and Development (OECD) used stakeholder engagement to inform the development of nanotechnology policy (OECD, 2012) and to build trust between policy makers and the public (OECD, 2001, 2005). Similarly, in the UK, stakeholder engagement has become a mandatory component of the policy development process (Cundy et al., 2013; Geaves and Penning-Rowsell, 2016). Both the Environment Agency and the Department for Environment, Food & Rural Affairs (Defra) regularly seek the participation of stakeholders (e.g. Society of Brownfield Risk Assessment) to improve policy (e.g. brown field risk assessment). The stakeholder engagement is used to address early warning signs of conflict that might affect the decision-making process. Similar approaches will help government address conflicts among stakeholders in the decision-making process in Ogoni. A robust stakeholder engagement process will allow different stakeholder groups to participate and contribute to decisions made, in the process social issues caused or aggravated by land contamination will be identified (Sam et al., 2017c), and addressed adequately in the contaminated land management process. Thus, societal expectations will be achieved in the process of contaminated land management (Zabbey et al., 2017).

Lessons from the Bodo Mediation Initiative (BMI) could add value to the wider Ogoni and Niger Delta remediation. The BMI is a participatory remediation management mechanism set up in 2013 by the Dutch Embassy in Nigeria, the National Coalition for gas flaring and oil spill in the Niger Delta (NACGOND) – a coalition of environment focused non-governmental organisations. The BMI facilitates clean up and rehabilitation of oil-impacted Bodo Creek. It involves broad spectrum of stakeholders including the Bodo community, operators, regulators, faith based groups, NACGOND and the Dutch Embassy (Zabbey and Arimoro, 2017). BMI adopts SCAT to manage the remediation process. SCAT is a multi-stakeholder expert team that provides advice on appropriate clean up techniques based on site assessment and certifies work done (Owens and Sergy, 2003).

4.6. Management of stakeholder expectation

Stakeholder expectations have been heightened since government announced readiness to implement the recommendations in the UNEP (2011) report on Ogoniland. These expectations may be parallel to the deliverables of the clean-up. Stakeholder engagement could be used to clarify grey issues. Aspects such as differences in stakeholder expectation and contaminated land management benefits would be clarified. For instance, as Zabbey et al. (2017) noted, some stakeholders erroneously think that the clean up and restoration of oil damaged Ogoni environments would be preceded by payment of monetary compensations. Some had been canvassing for monetization of the clean-up. This would likely be a major frustration for the HYPREP and certain operators who want to commence remediation (once safe to do so, and financial accountability is secure), but who are faced with further demands for monetary compensations and could be prevented from accessing land to start remediation. In addition, this could be a potential recipe for conflict in impacted communities. However, such wrong perception and disposition can be resolved through robust engagement. Participatory governance structures similar to the BMI could mitigate potential conflict.

4.7. Monitoring and evaluation

The clean-up process will require extensive monitoring and evaluation of the quality of work and adherence to the clean-up objectives and obligations. Academia, civil society and non-profit organisations should be actively involved in the monitoring of the remediation process. Quarterly or monthly reports could be made to a central authority (possibly a technical working group) which has the mandate to co-supervise the quality of work in the remediation process. However, this should be preceded by the development of success indicators specific for Ogoniland. Success indicators should include economic, environmental, and health indicators among others. These indicators would be used as a generic template to assess the success of the remediation activities in the different stages highlighted. Different monitoring groups including the regulators should jointly develop the indicators for ease of implementation, robustness, and participatory decision-making. In addition, international organisations such as UNEP should be actively involved in the supervision of the project, to provide prompt and appropriate consultation and ensure best practice is adopted in the clean-up exercise. To make this sustainable and enhance knowledge sharing and transfer, technical working groups (or committees) made up of local experts, community members and international experts should be set up. Such independent supervision will enable the implementing authority to take measures to ensure quality of work done meets local, national and international expectations.

4.8. Proposed road-map for livelihood improvement

The creation of livelihood opportunities to offset the gross underemployment in the Niger Delta region will require concerted efforts from all stakeholders particularly the government. In the following subsections, we identify the short-, mid- and long-term priorities for the Nigerian government to improve livelihood.

4.8.1. Short-term priority (within 2 years)

High priority within the shortest term includes:

- conduct a needs assessment in different communities to identify appropriate skills that would make the local communities useful in the remediation process
- outline effective training packages for identified skills
- develop an independent funding mechanism for the remediation process
- specify timeline for the clean-up

The rationale here is that the level of neglect in oil impacted communities is severe. Inclusion of non-impacted communities and assessment of the skill needs in the local communities will inform the training. In addition, remediation requires significant scientific and economic commitments – thus to prevent paucity of funds, an independent funding mechanism devoid of typical ministerial bottlenecks (and immune to corruption) is imperative. This reinforces the need to set up a specific and independent trust fund. The timeline is important to provide a guide and direction for the remediation. It is a veritable tool for measuring success and evaluation of the clean-up and remediation exercise.

4.8.2. Mid-term priority (3–7 years)

In the medium term, guidance should be provided on

- legalising HYPREP
- success indicators
- Bespoke RBSLs for Ogoniland and the wider Niger Delta
- Awareness creation and stakeholder expectation management

Currently, HYPREP is a project not backed by law. This is a concern given the unstable political environment within Nigeria. For example, the Constitution of the Federal Republic of Nigeria 1999 as amended defines four-year term for elected presidential government administration, after which a new government is inaugurated following fresh elections. Thus, policy difference between present and future government could affect HYPREP – and by extension the remediation exercise. Sustaining or strengthening policies of preceding government administrations is a perennial challenge in Nigeria. Therefore, it is imperative for the Nigerian government to institutionalise HYPREP. In addition, the development of success indicators (for evaluation), contextual standards and awareness creation is important for a successful remediation.

4.8.3. Long term priority (after 7 years)

In the long-term, a comprehensive body of legislation should be developed that incorporates prevention and management of air, water and soil contamination in Nigeria. Facilitated by the regulator responsible for the protection of human and environmental health, the new policy framework should clearly define what constitutes a contaminated environment, and the roles of different regulatory agencies and other stakeholder groups in sustainable terrestrial and coastal management, as well as identify the need for inter-agency planning and implementation. Plans should also be developed for training of personnel, provision of logistics, identifying and monitoring of oil spills, pipeline leaks and vandalism. As a result of the extent of environmental contamination in the region, the development of such a robust framework is overdue. Moreover, a framework that promotes inclusive stakeholder participation could be used as a reference for other developing countries (e.g. Ghana) in the region that face similar challenges related to natural resource mining. Follow-up of integrated coastal zone management initiatives that encourage local community participation and co-management is imperative to consolidate the clean up and remediation outcomes. This will also contribute to habitat and biodiversity conservation of the Nigerian coast and contiguous areas in the Guinea Current Large Marine Ecosystem (GCLME).

5. Conclusion

The study outlined the prospects of using bioremediation to bring about economic prosperity in Ogoniland and the Niger Delta at large. In addition to environmental clean-up, remediation and restoration, the study indicates that the exercise could be used to engender sustainable development in Ogoniland and its environs. The study identified opportunities for the creation of skilled and unskilled jobs, training, collaboration and the transformation of Ogoniland to a hub for contaminated land management learning and knowledge repository. These opportunities are not restricted to land and coastal remediation, but inherent in associated activities that will contribute to the success of the clean-up exercise such as the ICSMC. It is expected that knock-on effects from the remediation process will contribute to the economic prosperity of the region. The study proposed a short-, mid-, and long-term roadmap for government and HYPREP to adopt in addressing highlighted issues. The study highlighted possible solutions related to financial autonomy, need assessment research, training of local communities in different skills, legislation to back up HYPREP, and the development of success indicators for purposes of monitoring and evaluation. While this study presents a template for using remediation of Ogoniland to contribute to sustainable development, it is an exemplar for regions that have suffered extensive impact of natural resource mining and intends to restore moribund livelihood structures of impacted local communities.

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